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# COMPARATIVE ANALYSIS OF PHYSICAL DEVELOPMENT AND FUNCTIONAL CAPACITY OF DIFFERENT SPORTS ATHLETES DURING COMPETITION PERIOD

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The aim of this study was to compare physical fitness of high performance canoeists, rowers, Greek-Roman style wrestlers, basketball players and skiers during their competition period. Indices of physical development, muscle and fat mass and their ratios were obtained. Single muscular contraction power (SMCP) and anaerobic alactic muscular power (AAMP) were also measured. The anaerobic glycolytic power (AGP) was estimated by ergometer. The Bosco methodology was used to estimate the activity of fast twitch fibres (FTF). The psychomotor response time (PRT) and movement frequency (MF) per 10 s were estimated and Roufier index (RI) was applied to measure functional capacity of circulatory and respiratory systems. The examination of athletes specialising in five different sports allowed for identification of the peculiarities of sports specialisation. The distinctive height, highest body weight and static hand power values characterised rowers and basketball players; while canoeists had the highest muscle mass. Only canoeists achieved high SMCP during the competition period. The SMCP of rowers and skiers was optimal, whereas the basketball players and wrestlers demonstrated an insufficient single muscular contraction power. The highest anaerobic alactic muscle power was observed in basketball players and canoeists, whereas in the muscles the basketball players and wrestlers the activity of FTF was insufficient. Though its parameters were approximate to endurance-trained rowers, they considerably fell behind those of canoeists. The functional capacity of circulatory and respiratory system of skiers was highest. The research revealed that the majority of indices of skiers and wrestlers' physical fitness were lowest among the other studied athletes. Such results reflect their limited potential to achieve high results in international competitions.

***Key words:*** athletes of different sports, physical development, functional capacity.

## INTRODUCTION

High performance level athletes differ from untrained individuals in the level of their physical development and functional capacity of their body. The central nervous system, muscles and cardiovascular system of athletes are adapted to intensive physical loads and are able to maintain high performance for a long period [2, 20, 24]. In a number of sports the height gives a certain advantage: when actions require motion amplitude (rowing) or occur at a height (basketball). However, athletes from a big variety of sports, whose height and muscle mass do not differ considerably, are still distinguished by various physical qualities and energy processes in the muscles that are typical of the sports they are in [1, 11, 12, 21]. During the process of young athletes' selection and developing their physical qualities later, it is important to be aware of the fact that sports results are determined by a large number of internal and external factors. Internal factors include genotypic adaptation features of an individual, which determine his/her functional abilities, though they may vary under the influence of specific external factors (physical loads). Purposive and specialised sports education and development highlights the prevailing physical qualities and increase organism powers [4, 7]. The science of sports gains an interest in evaluation and comparison of functional powers of athletes from different sports during the competition period.

**The aim of the study** was to compare physical and functional powers of high performance canoeists, rowers, Greek-Roman style wrestlers, basketball players and skiers during the competition period.

## MATERIALS AND METHODS

The subjects were members of Lithuanian Olympic team: 8 canoeists, 4 rowers, 6 wrestlers of heavier weight classes, 9 skiers and 10 basketball players from a team playing in the Lithuanian Basketball League. All the athletes were investigated during their competition period.

Physical development, muscle and fat mass and their ratio were estimated ([16]). Single muscular contraction power (SMCP) [5] and anaerobic alactic muscular power (AAMP) were measured [14]. The anaerobic glycolytic power (AGP) of basketball players, wresters and skiers was estimated applying veloergometer [22]. Having modified this test, we measured AGP of rowers using ergometer and that of canoeists applying canoe-rowing ergometer. The Bosco methodology was employed to estimate the activity of fast twitch (FT) fibres [5]. The psychomotor response time (PRT) and movement frequency (MF) per 10 s were estimated and Roufier index (RI) was applied measuring functional capacity of circulatory and respiratory systems [25].

The results were statistically processed calculating the arithmetic mean value ( $\overline{X}$ ), representative response error ( $S\overline{x}$ ) and the reliability of difference in arithmetic means (p). A level of pL 0.05 indicated statistical significance.

## RESULTS

The physical development indices of Lithuanian athletes from different sports are specific. No difference was observed in the height of basketball players and rowers, but it was approximately 14 cm larger ($p < 0.05$) than that of canoeists, wrestlers and skiers (Table 1). The difference in athletes' height had a direct influence on differences in body weight parameters: basketball players weigh 12.12 kg ($p < 0.05$) more than canoeists and they weigh 22.41 kg ($p < 0.05$) more than skiers. However, the wrestlers and canoeists are heavier than the skiers by 8–10 kg ($p < 0.05$) on the average. The highest ratio of muscle and fat was observed among canoeists (7.02) and the lowest one (4.50 ($p < 0.05$)) was identified among wrestlers. Differences in the indices of lung volume (LV) among all the athletes studied were statistically unreliable ($p > 0.05$). The LV of the rowers was bigger by 20% compared to the other athletes in the research sample ($p < 0.05$).

The hand power of the basketball players was strongest: the power value of their right hand was 10% bigger and the power value of their left hand was 12% bigger than those of canoeists and respectively 17% ($p < 0.05$) and 16% ($p < 0.05$) higher compared to that of the wrestlers. The weakest hand power was identified in the group of skiers.

The analysis of indices of muscle work of different length and their functional capacity highlighted exceptional features of special training of athletes from various sports. The highest single muscular contraction power was characteristic of canoeists (30.10 W/kg), whereas the lowest SMCP value was identified among the rowers, which amounted to 26.18 W/kg (Table 2). The difference in this indicator of both athletes' groups equals to 13 per cent ($p > 0.05$). Stronger SMCP of the canoeists is determined by their shorter take-off length: 182.44 ms. The jump height of basketball players was considerably bigger compared to the other athletes (16 per cent higher than the jump of the canoeist ($p < 0.05$) and 25 per cent higher than that of the skiers ($p < 0.05$). However, due to the long take-off, the basketball players' SMCP reaches only 28.04 W/kg. Having compared the indices of basketball players with those of other athletes in the research, we may conclude that the relative SMCP of the basketball players is approximate to the parameters of endurance-training rowers and skiers.

The highest anaerobic alactic muscular power (AAMP) was achieved by the basketball players and its value was approximately 10% ($p < 0.05$) bigger than that of the rowers and 7 % bigger ($p < 0.05$) compared to the AAMP of the skiers. High AAMP is also characteristic of canoeist: this indicator is 8% ($p < 0.05$) bigger than that of the rowers and 6% ($p < 0.05$) bigger compared to the skiers. The absolute AAMP of the basketball players is considerably higher in comparison to the skiers (a difference of 28% ($p < 0.05$).

Differently from the indicators of SMCP and AAMP, the strongest anaerobic glycolytic power was identified in rowers. This indicator amounts to 624.67 W and is 34% ($p < 0.05$) higher compared to the AGP of the wrestlers. High AGP is also characteristic for canoeists and it is 12% higher compared to that of the skiers and 8 per cent bigger in comparison to the basketball players. The analysis of the relative AGP revealed that the rowers' AGP value is highest: 6.93 W/kg.

**Table 1**. Indices of physical development of athletes from different sports during competition period( $\overline{X} \pm S\overline{x}$ )

| | I | II | III | IV | V |
|---|---|---|---|---|---|
| **INDICES** | Canoeists n=8 | Wrestlers n=6 | Basketball players n=10 | Rowers n=4 | Skiers n=9 |
| Body height, cm | 182.69±1.98<br>I – V | 180.42±3.15<br>II–V, II–III | 194.90±1.72<br>III–I | 195.17±3.44<br>IV–V | 180.3±2.24<br>III–V |
| Body mass, kg | 82.59±1.83<br>I–III, I–V | 83.42±8.12<br>II–III, II–V | 94.71±2.25 | 90.17±1.86<br>V–IV | 72.30±1.47 |
| BMI | 24.38±0.32 | 25.72±1.68 | 24.90±0.64 | 23.67±0.88 | 22.55±0.53 |
| Strength of right hand, kg | 59±2.29 | 54.50±3.54<br>II–III | 65.8±3.04 | 63±3.21 | 53.09±2.8 |
| Strength of left hand, kg | 54.5±1.95 | 51.17±3.16<br>II–III | 61.60±2.75 | 56±2.31 | 49±1.68 |
| LV, l | 5.94±0.21<br>I–V | 5.2±0.37<br>II–V | 5.97±0.13<br>III–V | 6.87±0.23 | 5.41±0.14 |
| Muscle mass, kg | 45.03±1.25<br>I–V | 44.60±3.77 | 50.22±0.89 | 50.57±1.55<br>V–IV | 38.68±1.2 |
| Fat mass, kg | 6.73±0.62 | 10.57±1.71 | 8.49±1.11 | 8.71±0.95 | 7.04±0.51 |
| MFMI | 7.02±0.5<br>I–II | 4.5±0.42 | 6.94±0.98 | 5.97±0.77 | 5.82±0.49 |

Note: $p<0.05$

**Table 2.** Indices of muscular power, psychomotor functions and circulatory and respiratory systems functions of athletes from different sports during competition period (X±Sx)

| INDICES | I | II | III | IV | V |
|---|---|---|---|---|---|
| | Canoeists<br>n=8 | Wrestlers<br>n=6 | Basketball players<br>N=10 | Rowers<br>n=4 | Skiers<br>n=9 |
| Jump height, cm | 55.75±2.85<br>I–III | 54.33±1.09<br>II–III | 66.18±1.86 | 55.33±4.1<br>III–V | 48.91±2.43 |
| Take-off time, ms | 182.44±5.9<br>I–III | 215.18±39.8 | 235.73±5.96<br>III–IV | 211.9±19.65 | 182.52±10.4<br>III–V |
| SMCP, W/kg | 30.10±2.11 | 25.29±1.62 | 28.04±0.90 | 25.69±0.84 | 26.18±1.23 |
| SMCP, W | 2485±239.8 | 2099±291.3 | 2660±311.7<br>III–V | 2340±196.4 | 1879±319.8 |
| AAMP, W/kg | 17.06±0.41<br>I–II | 16.27±0.20<br>II–III | 17.25±0.32<br>III–V | 15.59±0.11<br>V–IV | 15.98±0.23<br>V–I |
| AAMP, W | 1411±128.1 | 1352±111.3 | 1615±196.6<br>III–V | 1404±101.1 | 1152±203.11<br>V–I |
| AGP, W/kg | 6.18±0.59 | 4.92±0.45 | 4.98±0.56 | 6.93±0.69 | 6.23±0.55 |
| AGP, W | 513±35.74 | 408.87±8.7<br>II–IV | 473.2±9.56<br>III–V | 624.67±22.62<br>IV–V | 449.40±16.2 |
| Activity of FTF, % | 52.14±2.81<br>I–III | 42.17±3.4<br>II–I | 41.18±2.51 | 43.33±1.45<br>V–I | – |

| | **I** | **II** | **III** | **IV** | **V** |
|---|---|---|---|---|---|
| INDICES | Canoeists | Wrestlers | Basketball players | Rowers | Skiers |
| | n=8 | n=6 | N=10 | n=4 | n=9 |
| PRT, ms | 189.75±8.17<br>I–V | 196.67±6.15 | 188.82±2.81<br>III–V | 210±3.58 | 191.27±6.24 |
| MF, t/10 s | 75±2.48 | 73.5±3.28 | 78.55±1.35 | 74±1.73 | 78.27±1.7 |
| HR<br>at rest, b/min | 68.3±3.09 | 59.33±3.37<br>II–IV | 62.82±1.99<br>III–IV | 58±2.0 | 56.22±1.75 |
| HR<br>after standard load, b/min | 120.16±3.74<br>IV–I | 116.5±1.96 | 121±4.09<br>III–IV,III–V | 105.33±2.67<br>V–I | 122.22±2.42 |
| HR<br>after 1 min rest, b/min | 79.33±1.61<br>I–IV | 68.00±3.43 | 73.09±2.7 | 66.65±2.67<br>V–I | 60.44±1.69<br>V–I |
| RI | 4.73±0.53<br>I–IV | 2.4±1.08 | 3.38±0.52<br>III–IV | 3.53±0.66<br>IV–V | 1.87±0.47<br>I–V |

Note: $p<0.05$

The highest activity of fast twitch fibres (FTF) was identified in the muscles of the canoeists (52.0 %), whereas the lowest FTF value was observed among the basketball players and it amounted to 41.18% ($p < 0.05$). The most approximate parameters of twitch fibre activity are in the group of the basketball players, wrestlers and rowers: there is only a 5 % difference among them.

Well-developed balance abilities of CNS and fastest psychomotor response time were characteristic of the basketball players. The worst results of movement frequency (MF) and psychomotor response time (PRT) were achieved in the group of rowers.

The skiers' resting heart rate (HR) was only 56.2 b/min, whereas that of the canoeists amounted to 68.3 b/min ($p < 0.05$). The skiers demonstrated the lowest HR response to standard physical load and increased only to 105.33 b/min, the heart rate of the basketball players reached the average of 121 b/min, and that of the canoeists – 120.16 b/min. The best recovery response (after 1 min recovery) was identified in the group of skiers with the heart rate decreased to 60.44 b/min, and the canoeists demonstrated the longest recovery with the heart rate of 79.33 b/min ($p < 0.05$) after 1 min recovery. The skiers' Roufier index (RI) was the best and equalled to 1.87, whereas the worst index value was observed in the group of canoeists and it amounted to 4.73.

## DISCUSSION

The competition activity of the athletes in the research sample is diverse: components of acyclic activity prevail in the actions of basketball players and wrestlers, when situation undergoes constant changes and movement is characterised through moments of shifting muscle power and complicated manifestations of psychomotor response. On the other hand, rowers, canoeists and skiers are involved in cyclic motion activity. Depending on the event, mixed anaerobic alactic, glycolytic energy generation reactions dominate and anaerobic capacity and endurance play the key role [8, 13, 21]. Our study revealed that the basketball players exceeded the other athletes in their height and body weight values. These indices of their physical development were higher compared to those of the wrestlers. The indices of basketball players' jump height and their relative anaerobic alactic muscle power were considerably higher compared to the athletes from other sports. Thus, it can be concluded that single and repetitive jumps, short spurts of acceleration activate anaerobic alactic energy generation reactions and develop single muscular contraction power.

The earlier researches have proved that higher height index and longer limbs give advantage while competing not only to basketball players but also to rowers [9, 17]. It can be concluded that the height of the rowers was significantly higher compared to that of wrestlers, canoeists and skiers but it did not statistically differ from the height index of basketball players.

A number of the authors [10, 15, 23] stated that special fitness of wrestlers is determined by their high anaerobic capacity. However, our research revealed that the relative indices of wrestlers AAMP and AGP were among the lowest in the sample.

Our results shows that single muscular contraction power did not have any substantial differences among separate groups of athletes. Though the basketball players jumped higher than the skiers, their single muscular contraction power was considerably weaker. This may be explained by the fact that basketball players and wrestlers' development of circulatory and respiratory system could have had a negative effect on single muscular contraction power [6, 18, 15]. No difference was observed in other forms of speed manifestation, i.e. psychomotor response time and movement frequency. Psychomotor response time is of extreme importance to basketball players but the PRS of the basketball players in the research was better only compared to that of the skiers. This proves that high performance basketball players failed to develop physical velocity qualities and separate forms of its manifestation to an appropriate level.

The highest activity of FTF among the athletes in the research was established in the group of canoeists (52.14%). Bergh et al. [3] stated that the FTF activity of Swedish National Team canoeists ranged from 29 to 53%. The muscle mass of the canoeists made up to 48% of the total body weight. A correlation was established between muscle mass and 200-meter distance time ($r = 0.66$) and the mass of special muscles and their power is of high importance for the results of 200-meter and 500-meter distances, whereas anaerobic capacity has a key relevance to the results of 1000-meter distance.

The heart rate at rest was highest in the group of skiers and amounted to $56.22 \pm 1.75$ b/min. The heart rate of an untrained individual is equal to 75–85 b/min, whereas the heart rate of a well fit skier may amount to 40 and sometimes even to 30 b/min [19].

The research results revealed that significant differences in qualities of physical development and physical fitness were not identified with an exception of the height and body weight parameters. This could have been conditioned by application of too low specific physical load and too intensive load in the sphere of general physical training.

## CONCLUSIONS

1. The examination of athletes specialising in five different sports allowed for identification of the peculiarities of sports specialisation. The distinctive height, highest body weight and static hand power values were characteristic of rowers and basketball players; however, the canoeists' index of muscle mass was highest in the sample.
2. Only canoes achieved high SMCP during the competition period. The SMCP of the rowers and skiers was optimal, whereas the basketball players and wrestlers demonstrated an insufficient single muscular contraction power. The highest anaerobic alactic muscle power was observed in the muscles of basketball players and canoeists.
3. The activity of fast twitch muscles was insufficient in the group of both the basketball players and the wrestlers. It was approximate to endurance-training rowers but was considerably lower than the activity of canoeists' FTF.
4. The research revealed that the majority of indices of skiers' physical fitness were lowest among the athletes in the research. Such results reflect their limited potential to achieve high results in the international competitions.

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